Bureau of Standards
JUL 29 1929

DEPARTMENT OF COMMERCE

TECHNICAL NEWS BULLETIN

OF THE BUREAU OF STANDARDS

ISSUED MONTHLY

Washington, July, 1929—No. 147

Reference book not to be taken from the Library.

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IDENTIFICATION OF TYPEWRITERS AND GUNS BY PRECISION METHODS OF COMPARISON AND MEASUREMENT

The following paper was presented by Wilmer Souder, of the Bureau of Standards, at the Twenty-Second National Conference on Weights and Measures, on June 5, 1929:

Identifications by comparisons have been made with more or less success for centuries. The application of precision measurement methods for these purposes is of recent origin and is not generally understood. This lack of understanding of the principles upon which the science is based is responsible for the confusion so often resulting from evidence introduced in courts of law.

We are so accustomed to the usual methods of description, which are only approximate and by virtue of these approximations are susceptible of no precise interpretations, that we fail to recognize the extreme accuracy of identifications made by precision measurements.

When we say we are looking for a man 6 feet tall of rather heavy build, with dark hair, with a scar on one hand, and with some gold teeth in his mouth, we should not be surprised to find several hundred citizens of the United States who meet the description. If we increase the precision of the description to a man 72½ inches tall, weighing 207 pounds, index finger of left hand amputated at the second joint, and with gold crowns on left cuspid and right bicuspids, we may feel sure there is not more than one man in the entire country who will meet the specifications, and having found this one, further search can not be justified without the introduction of some unusual condition.

The justification for this definite conclusion of positive identification is based on the "law of probability." Briefly and in nontechnical terms this law is interpreted from the fraction which represents the ratio of the number of times a specific characteristic appears divided by the maximum number of appearances possible, and for two or more characteristics appearing simultaneously the probability ratio is represented by the product of the individual fractions.

The bureau has taken up the problems of identification of typewritten documents, guns, bullets, etc., in an effort to establish standards for this class of work. The bureau's interest is purely scientific, and it is not prepared to handle cases in court.

There are now available a few experts who make identifications in a logical and precise manner, but there are many so-called experts who recognize no limitations, no standards, and no equipment as essential in this field.

The instruments which are now generally recognized as essential for satisfactory work in these fields are the results of years of effort on the part of men who have been actively engaged in this work and who have recognized the value of increased precision in making comparisons of data available for identifications.

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In each instance the positiveness of identification increases with the increase in number of agreeing characteristics, the narrower limits of measurement, and the increase in precision of measurements. When, if ever, these ideal conditions are established, there will be fewer conflicting expert opinions.

Precision measurements are the primary standards for identifications of questioned documents. The typewritten page may, at first glance, appear to be a perfect piece of work and not susceptible to an analysis of numerous individual characteristics which will prove it to be, beyond question of doubt, the product of one and only one certain machine. Type styles and characteristics distinguish one make of machine from another. Manufacturers using similar styles of type usually differ in dimensional proportions of the individual letters. For example, the "i" is given the same space as the "w" in the typewritten document, and it is the problem of the artist to design these and other letters in such manner as to minimize what could easily appear to be excessive crowding or isolation of type in the printed work. The modification of letters to avoid these defects gives the first opportunity for precision measurements.

For type made from the same model, or formed against the same die, we may look for defects or lack of all details of perfection over the lines of the letter face. The process of plating and polishing may add defects. The more sure source for identification, however, lies in the adjustments of the type on the bars after the machine has been completely assembled. Some letters will be placed high and some low in the line, some will be rotated and some will make contact on one portion of the face before the other portion hits the paper. Adjustments for minimizing these discrepancies are made by inspectors who usually reduce these to apparent uniformity in so far as the unaided eye is able to judge.

These variations are all susceptible to precision measurements, and when these are made and compared with measurements from other machines it will usually be found that 5 to 10 characteristics are sufficient to establish the identity of the machine which produced the document. The product of probability fractions rapidly reduce the probability of two machines existing which will produce documents having the characteristics specified. For the number of agreements given above and in the absence of unexplained disagreement the radio usually reduces below the ratio for the number of machines in existence and therefore justifies the conclusion of identity.

The excellence of this type of evidence arises from the consistency of the variations; the evidence speaks from every line of the document and, barring a few readily explainable variations, there are no contradictions. Attempts at destroying these beacon lights of evidence through mutilation are seldom successful, as to do so would require a perfect analysis of all defects in the machine, and facilities for this type of analysis are limited.

Some of the special types of instruments used for comparing typewritten documents are shown (lantern slides were used at this point in the address). These are designs suggested and used by Albert S. Osborne, New York City examiner in questioned documents. Here, as in all fields of metrology, the value of the measurement depends upon the precision of the instrument and the ability of the user. Inaccuracies in either render the results of little value. Experts in this field usually design their own types of measuring instruments and assemble numerous specimens of typewriting from which they draw conclusions as to what constitutes proof of identity.

Ballistic identifications have for their purpose the answer to the question—from what gun was a certain bullet fired? There is often a further question of identifying a case or shell as having been fired in the same gun. Evidence from measurements of guns, bullets, and shells have at present, in many instances, relatively little weight in courts of law except in their general confusion of juries and the development of a reasonable doubt. That is, to a large measure, because of the amateurish and incomplete methods pursued by many so-called experts. Properly prepared data on guns and bullets are often unique in the conclusiveness of identifications and often possess definite superiority over what is classed as direct visual evidence.

The points of superiority consist of the following: (a) The markings are definite and can not display false or perjured statements. (b) There is no limit to the time available for studying the case. (c) The mental state of the observer need not be confused, as is so often the case in visual observations of murders, etc. (d) The findings are available to all parties interested and wishing to verify the conclusions.

The make of a gun is sometimes available from the gross markings on the bullet. Measurements of the land and groove widths and depths, diameters, and twist markings of the barrel give data for the identification of make of gun. Further progress must be made from the characteristic markings which arise from imperfections in manufacture of barrel or breech mechanism. Rifling cutters do not have smooth edges. These tools wear with each cut, and the small saw toothlike projections along the cutting edge produce a constantly changing pattern in the barrel. Bullets pressed against this surface will take

these markings and retain them to a remarkable degree even after the penetration of many relatively hard materials. Rust spots and injuries to the inner surface of the barrel provide additional marks of identification. Firing pin and breech markings on shells are equally positive when the shells are available for comparison.

Briefly, the method of identification consists in comparing these characteristic markings on the questioned bullet or shell with the markings on a test bullet or shell fired through the gun in test. These tests are most satisfactory when made through a comparison microscope of the type perfected by the late Charles E. Waite and by Col. Calvin Goddard, of New York City. Images of the questioned and test bullets, or shells, from two microscopes each focused on a bullet or shell are combined in a single eyepiece. These images may be caused to make contact with each other at corresponding positions over the surfaces being examined.

Usually there will be a few lines on one surface which do not have their counterparts on the other. These correspond to fouling marks, pieces of metal or powder, rust cavities, etc., which have developed between the two shots in question. Experience shows these to be not contradictory but properly regarded as further proof of the constant changes taking place with use. Incidentally these accidental changes should not be expected to render two guns more nearly uniform but rather, by virtue of their promiscuity, to render them more divergent and individualistic in their markings. The identity is established through the agreement of the numerous fine markings present, the agreement of all major markings, and the absence of disagreements beyond those which may be ignored from the conditions mentioned above.

Bullets deformed by impacts with bones or other substances require special study, as the dimensions of markings can not be expected to agree precisely with dimensions taken from the gun or from undistorted test bullets.

Skill in this field requires ability in the use of the microscope and in the ability to make precision measurements of diameter, angle, and width of markings. Visual and photographic evidence must be complete and readily understood if it is to be of value in evidence.

Eventually it is predicted that this method of identification will be standardized and will furnish one of our most reliable means of identification.

The bureau plans to issue a publication on this subject, but it will not be available until some time in 1930.

INVESTIGATION OF LOSSES FROM LIGHTNING

In 1924 the Western Actuarial Bureau instituted an investigation among electric light and power companies in the territory west of the Alleghany Mountains reaching to the Pacific Coast and extending from Canada to the Gulf of Mexico. Arrangements were made with 248 companies in this territory to supply data regardnig the value of the property exposed and the nature and financial extent of the damages caused by direct strokes of lightning or by surges occurring on their lines during lightning storms. The data secured covered principally the calendar years 1925 and 1926. Two hundred and forty companies, scattered over 30 States, sent in data. One hundred and sixty-five of these companies covered a period of at least two years. The only State in the specified area from which losses were not reported was Utah.

The total value of the properties exposed to damage by lightning of the companies reporting amounted to about $819,756,000. This value includes power houses and substation buildings, contents, and outdoor apparatus. The total losses attributed to lightning over a 2-year period amounted to slightly more than $631,000, or about 0.04 per cent per annum.

The results of this survey have recently been analyzed by engineers of the Bureau of Standards, and some interesting data have been secured regarding the detailed damage to the electrical apparatus. The table below will give some idea of the distribution of damage among different classes of equipment within stations and upon the overhead lines. Without counting interruptions to service due to circuit-breakers being tripped or fuses blown and without counting instances of additional damage to fuses, there were reported altogether 4,450 instances of damage, and in 4,099 of these cases protection had been provided in the form of lightning arresters

of one type or another. In presenting the results nothing is said about the types of arresters involved, since the total number of arresters of each type is not known, and consequently the number of cases of damage involving each type of arrester would not serve to discriminate as to the relative protective value of the different types. Neither has any attempt been made to indicate the value of arresters in general, since without knowledge of the amount of protection provided calculations can not be drawn as to the extent to which protection was actually afforded. It is, of course, impossible to determine how much damage would have resulted if arresters had not been used at all.

Number of pieces of apparatus damaged	Total	Having arrester protection
Transformers, including 296 bushings	1,774	1,610
Metering equipment	1,280	1,250
Lightning arresters	137	
Rotating machines	117	110
Oil switches, including 30 bushings	146	133
Air-break switches	71	61
Switchboards	13	13
Bus structures or insulators	35	34
Potheads	5	5
Line insulators	408	371
Line conductors	241	215
Pole or cross arm	215	155

It is to be noted that during the period in which 1,774 cases of damage to transformers occurred there were 137 cases of damage to lightning arresters, or 1 case of injury to the arrester for every 13 injuries to transformers. While there is not a complete record of the voltage of each line upon which damage occurred, it may be said that most of the damages here tabulated occurred upon lines of low or medium voltage.

As an indication of the relative prevalence of lightning damage in the different States, data were selected where companies had reported the mileage of line exposed. The product of the number of miles of primary line and the number of lightning seasons involved in the records was divided into the number of instances of lightning damage upon those lines. The quotient thus obtained may be regarded as a coefficient showing the frequency with which lightning damage has occurred per mile per season. The values of this coefficient are given in the following table:

State	Coefficient of frequency of lightning damage
Idaho	0.00055
California	.0062
Arizona	.012
Ohio	.013
Indiana	.023
Colorado	.026
Kansas	.026
Iowa	.032
Illinois	.033
Kentucky	.039
Arkansas	.072

Not all of the companies reporting gave data in a form to be used in this computation, and in some of the States there were not enough data to warrant making a computation for that State. The results in this table are based upon too few data to be highly reliable, but it is to be noted that States in the zone of most numerous lightning storms have the higher coefficients, while those far west show lower values.

The data collected disclose other items of interest. The frequency at which various companies are operating included the values of 20, 25, 30, 33, 50, and 60 cycles per second, although more than 96 per cent of the companies were using the latter value. While the voltages most commonly reported were those known to be in general use, such as 2,300, 6,600, 11,000, 13,200, 22,000, 33,000, 60,000, and 66,000, there were altogether 74 values of voltage reported running all the way from 60 to 125,000 volts. This indicates that the selection of operating voltages is in this country far from being standardized. More than 70 per cent of the lines reported, however, were operating at some one of the voltages above enumerated.

About 80 per cent of the lines involved in this survey were reported as being provided with lightning arresters and about 20 per cent as lacking such protection.

SAFEGUARDING STORAGE OF FILMS

In connection with the firemen's short course given at the University of Illinois a paper was presented on June 18 by C. R. Brown, of the Bureau of Standards, on Safeguarding the Storage of Photographic, X-Ray, and Motion Picture Films.

The recent disaster in Cleveland has emphasized the importance of proper storage of such films, large accumulations of which are often present in hospital buildings.

Most of the film used for the purpose up to the present has been of the nitrocellulose type, that ignites at relatively low temperature, burns very rapidly, and gives off poisonous and flammable gases.

The storage of such film should be made in vaults constructed to resist moderate pressure from the rapid combustion of the film and mild explosions which sometimes accompany the fire. Suitable vents should be provided to the outside of the building for the gases given off. Self-closing doors, preferably opening inward into the vault, should be provided, with sufficient strength to resist the pressure.

The arrangement within the vault should be such as to minimize the possibility of ignition of the film and at the same time afford easy extinguishment of fire by means of the automatic sprinkler protection required for such storage.

TESTING LATHE TOOLS WITH SHALLOW CUTS AT HIGH SPEED

The bureau has developed a method for testing lathe tools under shallow cuts and fine feeds. It is based upon the fact that when two tools are set at equal depths in one tool holder the second or "trailing" tool will not cut until the "leader" or cutting tool begins to wear. With the carbon and high-speed steel tools used, the second tool began to cut when the leader had worn 0.001 to 0.002 inch, and at this point the leader or test tool was considered to have failed. All subsequent comments on turning with shallow cuts and fine feeds are based on this end point, but greater wear can be made to represent tool failure by using a shallower setting for the second tool than for the cutting tool.

Tests were made dry at different cutting speeds, feeds, and depths of cut on nickel steel forgings with tensile strengths of 80,000 to 100,000 lbs./in.^{2} to give a broad background for the interpretation of the results of tests of different tool steels, first heat treated in various ways. The results could be represented approximately by the following equations, in which V is the cutting speed, T the tool life, F is the feed, D the depth of cut, A is the area of cut (=DF), c, K, K_1, K_2, and n are constants.

For high speed steel tools

$$VT^{\frac{1}{n}}=c \qquad (1)$$

$$V=K_1-K_2(DF)=K_1-K_2A \qquad (2)$$

For carbon steel tools

$$V=\frac{K}{DF}=\frac{K}{A} \qquad (3)$$

These equations are not to be construed to represent the true laws of cutting, since the cutting speed is probably not affected equally by variations in the feed and the depth of cut. However, they represent approximately the results of the experiments made with depths of cut of 0.005 to 0.020 inch and feeds of 0.0115 to 0.0204 inch per revolution.

In tests of short duration, where tool failure occurred in about 2 to 10 minutes, the tool life was increased somewhat more by the use of water than by lard oil, but in tests of about 50 minutes duration, under the same feed and depth of cut but lower cutting speeds, these two liquids produced effects of the same magnitude. The increases in tool life from the use of these liquids were not large in any case, but the finish on the work piece at the end of the cut was better with the liquids than without.

Tests with tools of different forms and angles showed that the successful application of the described method of test was not dependent upon having the broad-nose tool used in a majority of the experiments. Tools with a plan angle of 65° had a longer life than the broad-nose tools, but the finish produced on the nickel steels in dry turning did not appear to be as good. The best tool life with the broad-nose tools was obtained with a back slope of 30°; a side slope of 0° was better than 8°.

The cutting speed of quenched carbon steel tools was not affected appreciably by variations in carbon content from 0.75 to 1.3 per cent nor by subsequent tempering at temperatures up to 375° F. which did not lower the harness; the cutting speed of the carbon steel tools was equal approximately to that of a quenched "oil hardening" tool steel and only slightly lower than the cutting speed of a steel containing 1.3 per cent carbon and 2.75 per cent tungsten.

The cutting speed of carbon steel tools was lower in all cases than that of high-speed steel tools, but the differences between the two decreased with decrease in the areas of cut in dry turning.

The heat treatments which resulted in the best roughing tool performance for high-speed steels of customary compositions also resulted in superior performance under shallow cuts and fine feeds. These treatments comprised oil quenching from the highest practical temperatures, followed by tempering to convert the larger part of the retained austenite to martensite.

Of 12 elements added in different proportions to chromium-tungsten or chromium - tungsten - vanadium high - speed steels only one (cobalt) produced decidedly beneficial results. Molybdenum and nickel offered promise under certain conditions, while the remainder either had a negligible effect or were definitely deleterious from one viewpoint or another.

Cobalt improved the performance of the high-speed steel tools both under shallow cuts and under heavy duty, but the maximum benefits were obtained only with high hardening temperatures. The percentage gain from the addition of cobalt was somewhat greater in rough turning than with shallow cuts and fine feeds, but increase in cobalt above about 5 per cent did not produce improvements commensurate with those resulting from 3.5 to 5 per cent plus high hardening temperatures.

Replacement of part or all of the tungsten in high-speed steels by molybdenum, in the ratio of 1 part of molybdenum to 2½ parts of tungsten, produced steels having performance comparable to that of the tungsten steels. Such substitution should be useful in case of a depleted tungsten supply but is not advocated at the present time, since there was some evidence of irregular performance in the high molybdenum steels, and their hot working properties did not seem to be as good as those of the tungsten steels. However, a steel with 7 per cent molybdenum and no tungsten had one advantage over the tungsten steels for roughening tools, in that its hardness and performance were not so largely affected by variations in the hardening temperatures.

The addition of 3.75 per cent of nickel to the customary chromium-tungsten-vanadium steels was beneficial for the rough turning tools, particularly when combined with a 50° F. increase in the hardening temperatures, but was detrimental to the tools used under shallow cuts and fine feeds, and adversely affected the machining properties of the high-speed steel itself. Lowering the carbon from 0.6 or 0.7 per cent to 0.5 per cent improved the machining properties without affecting the performance of the roughening tools but was detrimental to the tools used under shallow cuts.

Each of the four elements—arsenic, antimony, copper, and tin—adversely affected the tool performance of high-speed steels under shallow cuts, the magnitude of the decrease becoming greater as the proportions of these elements increased. Copper was the least

harmful; next in order came tin, while arsenic and antimony were the most objectionable.

The effects of these four elements upon the performance of roughing tools did not necessarily correspond to those observed with shallow cuts. The 0.8 per cent arsenic addition lowered the cutting speed. The addition of 0.4 per cent antimony or 0.5 per cent or less of tin had no measurable effect. Higher proportions of tin lowered the cutting speeds. The high-speed steels containing 0.36 to 1.77 per cent copper showed slightly better performance than the corresponding steels without copper.

The steels containing 0.4 per cent antimony, 0.8 per cent or more of copper, or 0.8 per cent arsenic did not have good hot-working properties, illustrated by numerous corner cracks on the bars, while those containing 1.7 per cent antimony or 1.8 per cent tin showed a high degree of hot shortness and could not be forged or rolled. Also the steel with 1.77 per cent copper could itself be machined only with difficulty in the annealed condition.

Phosphorus up to about 0.06 per cent and sulphur up to 0.215 per cent did not appear to be injurious from the viewpoint of lathe-tool performance of the customary chromium-tungsten-vanadium steels, with or without cobalt. However, high sulphur tended to lower the cutting speeds in the presence of 3.75 per cent nickel. Because of the possibility of segregation of the phosphorus and the introduction of numerous sulphide inclusions in high sulphur steels these two elements can advisedly be kept within low limits for all high-speed steel lathe tools.

Aluminum adversely affected the performance of the high-speed steel tools both with shallow cuts and under heavy duty. It was one of the few metals considered which in proportions around 0.3 per cent, produced a measurable decrease in the cutting speeds in rough turning. This decrease became greater as the proportion of the aluminum was increased, and with 0.8 per cent the drop in cutting speed was greater than that produced by equal proportions of any of the other elements considered. These changes were accompanied by decrease in the hardness of the quenched steels, probably through decrease in the dissolving capacity of the aluminum iron solid solution for carbon, chromium, tungsten, and vanadium. With 0.8 per cent aluminum there was also evidence of a low melting eutectic in samples quenched from 2,350° F.

Titanium was another of the elements which appeared to lower the dissolving capacity of the austenite, and as a result the hardness and the cutting speeds of the high-speed steel tools decreased with increase in the titanium. Its interference was lessened, probably through the formation of less harmful carbides, instead of solution as titanium in the austenite, by increasing the carbon content of the steel.

Tantalum did not appear to be promising as a substitute for vanadium or as an alloying element in the customary chromium-tungsten high-speed steels for lathe tools. It acted in a manner similar to aluminum and titanium in that it appeared to decrease the dissolving power of the austenite for the chromium and tungsten compounds, and in this manner decreased the hardness and cutting speeds of the quenched lathe tools.

The complete report of this work will be published in the near future in the Bureau of Standards Journal of Research.

FREEZING TESTS ON SAND-LIME BRICK

Some preliminary experiments have been made to determine the best procedure for conducting a series of freezing tests on sand-lime brick.

Twenty-four bricks of a single manufacture were used. They were divided into four groups, each group representing as nearly as possible an equal range of absorptions, as determined by a 72-hour cold, total-immersion test. All brick were given 10 cycles of freezing

and thawing, the proceedure being varied for each group. Bricks of set 1 were frozen in ½ inch of water immediately after the 72-hour soaking. Bricks of set 2 were frozen with no surrounding water, the first freezing starting directly after the 72-hour soaking. The other two sets were both cooled each time to 0° C. while totally immersed. Set 3 was then frozen in ½ inch of water and set 4 was frozen with no surrounding water. All brick were wiped with a damp cloth and weighed after each thawing. After the 10 cycles the brick were dried to constant weight in a gas-fired oven at 110° C. and reweighed.

It was found that the loss in weight of the bricks ranged from 0.3 to 2.8 per cent of the original dry weight, and that as a rule the bricks with the higher water absorption had the lower percentage loss. The bricks of set 2 showed a somewhat lower average percentage loss than the others, it being 1.0 per cent. The six bricks of set 4 were next lowest, with an average loss of 1.2 per cent. The others showed losses of 1.5 per cent.

The increase in water absorption was also calculated. It was found that the average increase in absorption for all the brick from the end of the 72 hours' total immersion to the end of the 10 cycles was 2.8 per cent, the final absorption being calculated from the final dry weight. Set 1 had the largest increase, averaging 3.4 per cent, while set 4 had the smallest, averaging 2.2 per cent. These results were obtained on only one make of brick, and it would be unwise to draw any conclusions from them. Similar tests on a number of makes of brick are in progress.

PNEUMATIC TIRE EQUIPMENT

Letter Circular No. 267 on pneumatic tire equipment, which was released by the bureau last month, will be found of considerable practical value to motorists.

This letter circular points out that the use of oversize tires, which can be run at considerably less than their usual load, will result in reduced expenses per mile and fewer interruptions in service. Satisfactory performance can sometimes be obtained from second-grade tires by running them under light loads. The increasing use of 6 and 8 ply balloon tires is mentioned, and for heavy service such tires are recommended. Valuable hints on the purchase and use of tires are included.

Copies of this letter circular may be had free on application to the Bureau of Standards, Washington, D. C.

MEASUREMENT OF THE BULK OF PAPER

Paper varies in character from light, fluffy material to dense, compact sheets. The degree of fluffiness is known in the paper industry as bulk. This property is of interest chiefly in connection with bound volumes. It is desired to have some books light but thick and others as thin as possible for a given weight. The property of bulk has a great deal to do with the character of a book in this respect. Owing to the fact that there is no standard method or uniformity of procedure in the measurement of bulk the bureau has recently made a study of the different means of measuring this property of paper. It was found that the different pressures used in the variable-pressure type of apparatus and the use of an insufficient number of sheets in the case of measurements with thickness gages are chiefly responsible for the diversity of results ordinarily obtained. As a result of comparative tests made on different types of apparatus and at various pressures it was found possible to select procedures for the two most commonly used measuring devices so as to bring them into substantial agreement with each other and with the bulk actually obtaining in bound volumes.

A standard procedure is recommended which permits either the measurement of a pack of paper 0.1 inch or more in thickness with a thickness gage of standard type, or the measurement of a 1-inch pack under a pressure of 5

lbs./in.^{2} by means of a pressure bulker. It is recommended that the results be expressed as (*a*) bulking thickness, or the thickness in hundredths of an inch of a 100-sheet pack, and (*b*) specific bulk, or the ratio of bulking thickness to the standard ream weight of the paper measured.

Further details of the results of this study are given in the June number of the Bureau of Standards Journal of Research.

EXPERIMENTAL PRODUCTION OF ROOFING FELTS

An investigation is being conducted at the bureau to determine the relative value of different fiber compositions in the life and serviceability of asphalt-saturated and coated roofing felts. Experimental felts composed of varying proportions of the usual felt-making fibrous materials, and with a high content of low-grade substitutes not employed commercially in roofing felts, were made for the investigation.

The paper-making materials employed were No. 2 roofing rags, old jute and manila bagging, old newspapers, and finely ground wood sawdust. One felt contained as high as 60 per cent of wood-fiber papers and 30 per cent of sawdust. The paper-making processes consisted of beating the raw materials and converting the prepared stock into a sheet of paper or felt. The felt papers were made in the semicommercial paper mill of the bureau and were saturated and coated, and thus converted into roofing, in a commercial roofing mill.

No difficulty was experienced in making the basic papers on the bureau's Fourdrinier paper machine nor in saturating and coating them in the commercial roofing mill.

The experimental papers were subjected to very thorough tests, all of the tests commonly used in the roofing industry for roofing felts being applied. These are weight, thickness, strength, fiber composition, pliability, saturating properties of the basic papers, and the amount of saturating materials in the finished felts, as well as their heat and water resistance. The laboratory test results compared very favorably with those obtained for similar grades of commercial felts.

The results indicate that relatively large amounts of substitute materials can be used in admixture with rag stock without causing great difficulty in the manufacturing processes. The work at the bureau was on a semicommercial scale, but comparison of the data for the experimental and the commercial felts indicates that the results obtained can be applied directly to commercial practice.

If the durability tests now in progress show that the presence of the substitutes does not decrease the life of the felts in service, the use of these materials in admixture with rag stock would effect considerable economy in the production of roofing felts. The lower cost of the substitute materials and the saving in time and power required for the paper-making process would both contribute materially to reduce the manufacturing costs.

A detailed report of this investigation was published in the June number of the Bureau of Standards Journal of Research.

SPECTRA OF CHLORINE, BROMINE, IODINE, KRYPTON, XENON, AND ARSENIC

With the assistance of Dr. T. L. deBruin, of the physics department of the University of Amsterdam and a research fellow of the International Education Board, the bureau has made remarkable progress during the past 10 months in the description and interpretation of the spectra characterizing certain of the chemical elements which have not been thoroughly studied heretofore. These included the halogens, chlorine, bromine, and iodine; the heavy gases, krypton and xenon; and the metal, arsenic. The halogens usually give mixtures of several types of spectra, among which it is difficult to recognize that produced by the neutral atoms. The

inert gases, krypton and xenon, exist in the earth's atmosphere, but only in very minute quantities, the former constituting but 0.00005 and the latter 0.000006 per cent. This is one of the principal reasons why their spectra have not been seriously studied since shortly after the discovery of these gases in 1898. Nothing of importance had been added to our knowledge of the arc spectrum of arsenic since an ultra-violet portion of it was first described in 1893.

Standard descriptions of these long-neglected spectra have now been prepared by the bureau. In each case important extensions have been made to the infra-red portions, which have been investigated photographically by special methods developed in the bureau's laboratory, and it is in fact these observations which have given the clues to the spectra. The structure of the spectrum in each case is determined by the structure of the atom, and the latter may be deduced from the former by identifying various states of atomic energy from certain relationships between the emitted lines.

The interpretation of any spectrum has been made possible in recent years by the advances in quantum theory, but in most cases the empirical data are still too incomplete or inaccurate to permit complete analysis. Many laboratories the world over are now engaged with these problems. Any one of them is proud if it finishes one spectrum a year. The Bureau of Standards, with the services of Doctor deBruin, has established a record by defining and explaining no less than six different spectra in a period of 10 months.

CONFERENCE ON AIRPLANE-ENGINE IGNITION SHIELDING

A conference on airplane-engine ignition shielding was held at the bureau on Tuesday, June 11, for the purpose of coordinating information available on the subject and stimulating the standardization of shielding practice. This was called and conducted by the bureau, in response to a number of requests. There were 57 persons present, representing the interested Government departments, airplane, airplane engine, magneto, spark plug, and cable manufacturers, as well as the manufacturers and research organizations interested in the use of radio on aircraft.

Talks were given by representatives of the various interests on their experience with ignition shielding and the points to be considered in an ideal installation. Some of the representatives displayed samples of their most recent development in this line, and the Bureau of Standards exhibited a complete shielding assembly showing its recent developments. Tentative specifications enumerating the various requirements for effective and safe ignition shielding were discussed. There was good agreement on the factors essential to proper radio shielding. The main discussions were centered around standardization of magneto shielding, spark-plug shielding, and standard tests to determine efficiency of shielding.

A report of this conference is being prepared. Copy can be secured by anyone interested on application to the Bureau of Standards, Washington, D. C.

NEW AND REVISED PUBLICATIONS ISSUED DURING JUNE, 1929

Journal of Research [1]

Bureau of Standards Journal of Research, Vol. 2, No. 6, June, 1929. (RP Nos. 67 to 76, inclusive.) Obtainable only by subscription. (See footnote.)

[1] Send orders for publications under this heading with remittance only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 25 cents per year (United States and its possessions, Canada, Cuba, Mexico, Newfoundland, and Republic of Panama); other countries, 40 cents. Subscription to Bureau of Standards Journal of Research, $2.75; other countries, $3.50.

Research Papers [1]

(Reprints from Journal of Research)

RP72. The spotting of plated or finished metals; W. P. Barrows. Price, 10 cents.

Commercial Standards [1]

CS5–29. Steel pipe nipples. Price, 10 cents.

CS6–29. Wrought-iron pipe nipples. Price, 10 cents.

United States Government Master Specifications [1]

USGMS. 258b. Cloth, airplane, mercerized cotton, grade A. Price, 5 cents.

Miscellaneous Publications [1]

M85. Specifications and tolerances for commercial weighing and measuring devices (Superseding Handbook No. 1). Price, 50 cents.

M89. Report of the National Screw Thread Commission (Revised, 1928). Price, 50 cents.

M92. Code for protection against lightning. Approved by American Standards Association. Price, 25 cents.

Technical News Bulletin [1]

TNB147. Technical News Bulletin, July, 1929. Obtainable only by subscription. (See footnote.)

OUTSIDE PUBLICATIONS [2]

Precautions against stray magnetic fields in measurements with large alternating currents. F. B. Silsbee; Paper before convention of American Institute of Electrical Engineers (New York, N. Y.); June 24–28, 1929.

Airway beacons. F. C. Breckenridge; Aero Digest (New York, N. Y.); Vol. 14, No. 6, p. 76; June, 1929.

Correcting engine tests for humidity. Donald B. Brooks; National Advisory Committee for Aeronautics (Washington, D. C.); Technical Note No. 309; June, 1929.

The severity of fires in buildings. S. H. Ingberg; Architectural Forum (National Buildings Publications, New York, N. Y.); Vol. I, No. 5, p. 775; May, 1929.

Fire resistance tests with particular reference to wall constructions. S. H. Ingberg; Proceedings, 29th annual convention of the Sand-Lime Brick Association (Saginaw, Mich.), p. 37; 1929.

Trying the power of flame. S. H. Ingberg; United States Construction Quarterly (Washington, D. C.); Vol. I, No. 1, p. 13; January–March, 1929.

The present status of light sources and window materials in light therapy. W. W. Coblentz; Journal, American Institute of Electrical Engineers (New York, N. Y.); Vol. XLVIII, No. 5, p. 397; May, 1929.

Sources to ultraviolet radiation and their physical characteristics. W. W. Coblentz; Journal, American Medical Association (Chicago, Ill.); Vol. 92, p. 1834; June 1, 1929.

"Made weather" tests paints. P. H. Walker; United States Construction Quarterly (Washington, D. C.), Vol. 1, No. 1, p. 3; January–March, 1929.

Strength of tubing under combined axial and transverse loading. L. B. Tuckerman, S. N. Petrenko, and C. D. Johnson; National Advisory Committee for Aeronautics (Washington, D. C.), Technical Note No. 307; June, 1929.

Reaction of water on calcium aluminates. L. G. Wells; Review of RP–34, published in December, 1928. G. Gianoli; Giornale di Chimica Industriale ed Applicata (Milan, Italy), Vol. XI, No. 4, p. 189; 1929.

[1] Send orders for publications under this heading with remittance only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 25 cents per year (United States and its possessions, Canada, Cuba, Mexico, Newfoundland, and Republic of Panama); other countries, 40 cents. Subscription to Bureau of Standards Journal of Research, $2.75; other countries, $3.50.

[2] "Outside publications" are not for distribution or sale by the Government. Requests should be sent direct to publishers.

Constructions own agency. Division of building and housing aids builders, James S. Taylor; United States Construction Quarterly (Washington, D. C.), Vol. I, No. 1, p. 3; January–March, 1929.

The following papers were delivered at the 32d annual meeting of the American Society for Testing Materials (1315 Spruce St., Philadelphia, Pa.) and will be published in the Proceedings:

Influence of mineral composition of aggregates on fire resistance of concrete, S. H. Ingberg.

Water absorption and penetrability of brick, J. W. McBurney.

Tests of elastic caulking compounds, H. H. Dutton.

Bearing bronzes with and without zinc, H. J. French.

Effect of corrosion, accompanied by stress, on the tensile properties of sheet duralumin, H. S. Rawdon.

U. S. GOVERNMENT PRINTING OFFICE: 1929